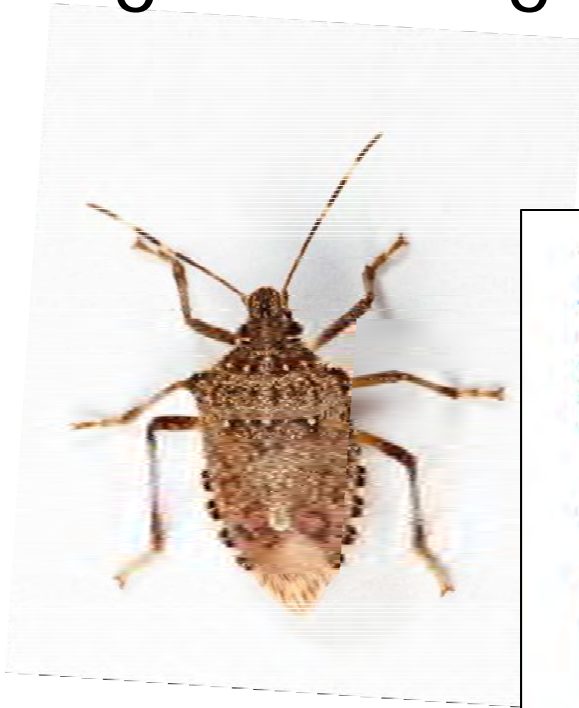


1.1.1 : Voltinism – number of generations

Caged rearing at multiple locations



Funding



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

Specialty Crop Research Initiative
Grant #2011-01413-30937

Collaborating Institutions



Cornell University



Virginia Tech



1.1.1 : Voltinism – number of generations

Phenology – the timing of biological events

Anne Nielsen – Rutgers

Shi Chen –College of Veterinary Medicine, N C State

Shelby Fleischer – Penn State

Nic Wiman – Oregon State



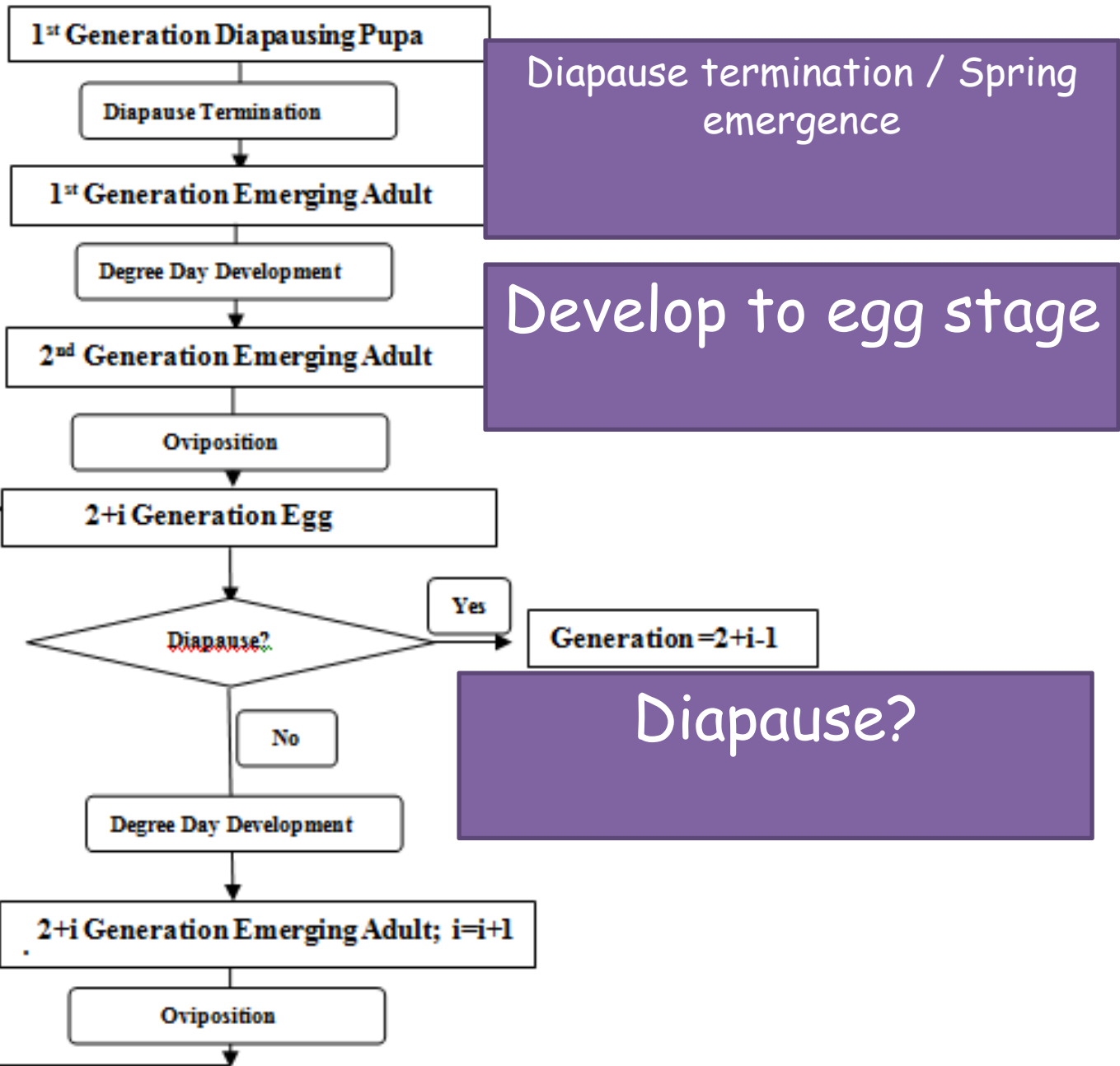
Funding		Specialty Crop Research Initiative Grant #2011-01413-30937	
	United States Department of Agriculture	National Institute of Food and Agriculture	
Collaborating Institutions			
			
	Northeastern IpM Center		
			
			

Individual Based Models

- Pros
 - Track each individual explicitly
 - Deal with distributions for input and output
 - Easy to incorporate variation
 - Easy to visualize

- Cons
 - Need to have comprehensive knowledge
 - Computational burden

Grape Berry Moth



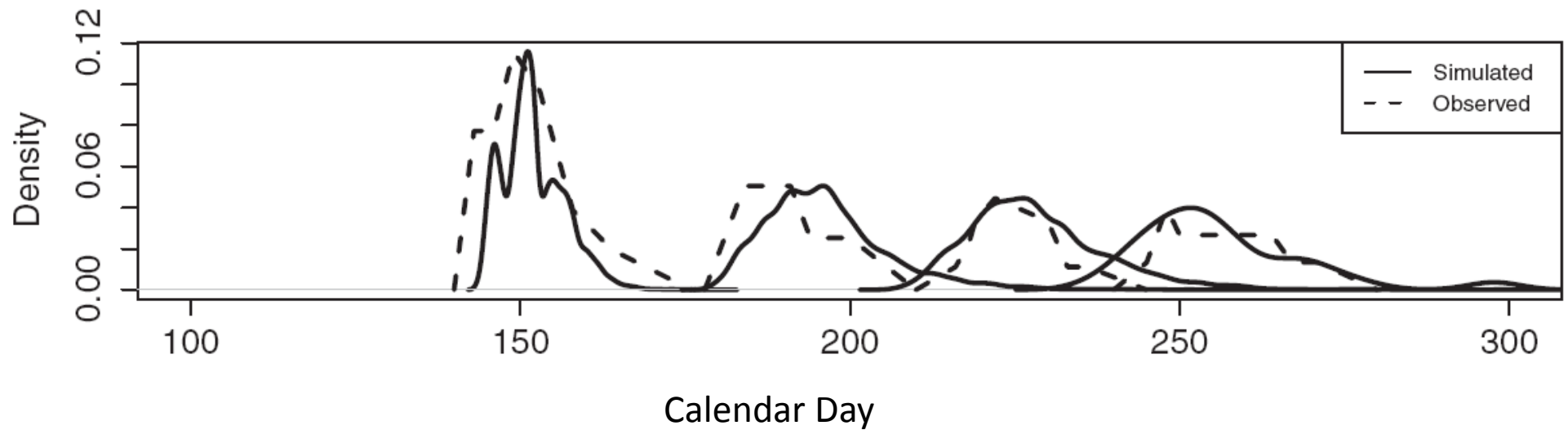
Diapause termination / Spring emergence

Develop to egg stage

Develop to Egg Stage or Die

Diapause?

Validation with 2007 malaise trap data



S. Chen, P. C. Tobin, M. C. Saunders, and S. J. Fleischer. 2011. Projecting insect voltinism under high and low greenhouse gas emission conditions. *Environ. Entomol.* 40: 505-515

1000 females

Diapause termination

P adult survivorship

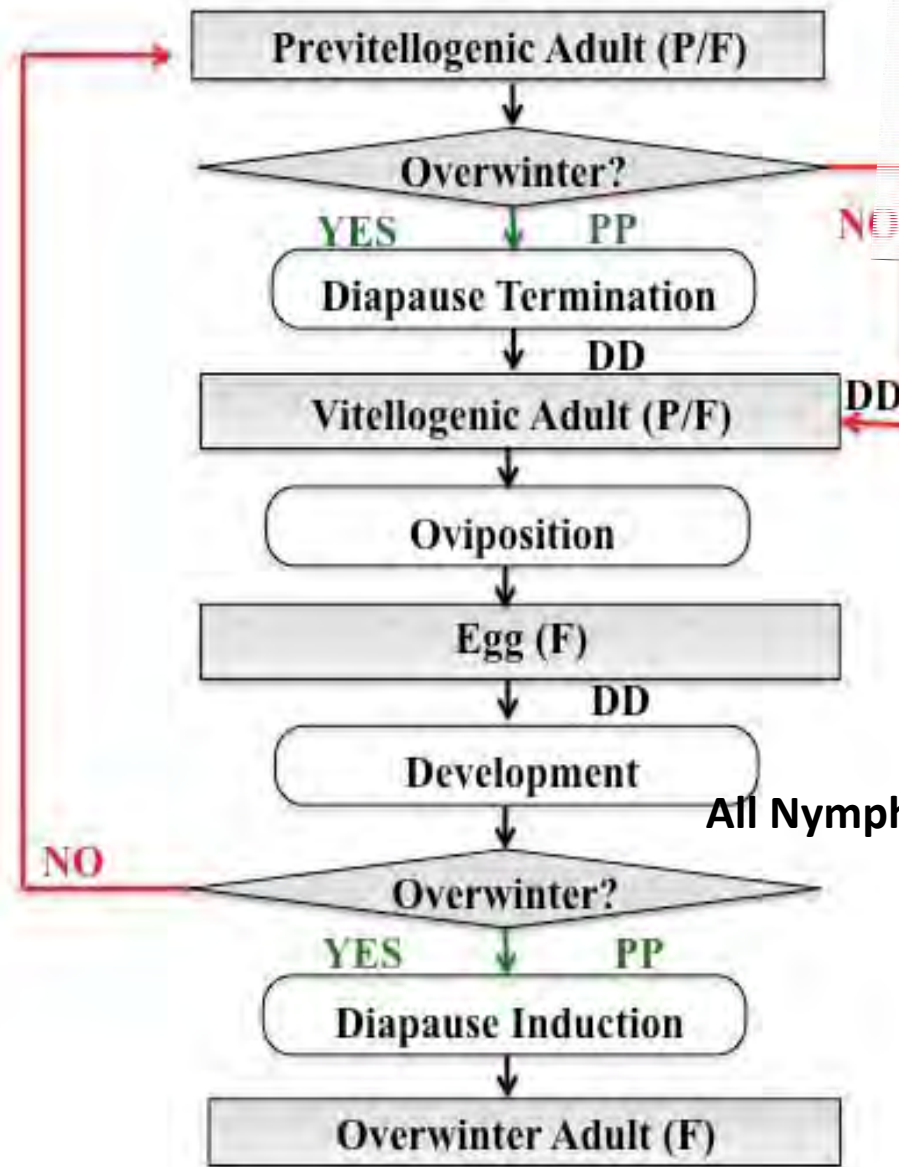
Fecundity

Nymphal Development

Nymphal Survivorship

F_x survivorship

Diapause initiation



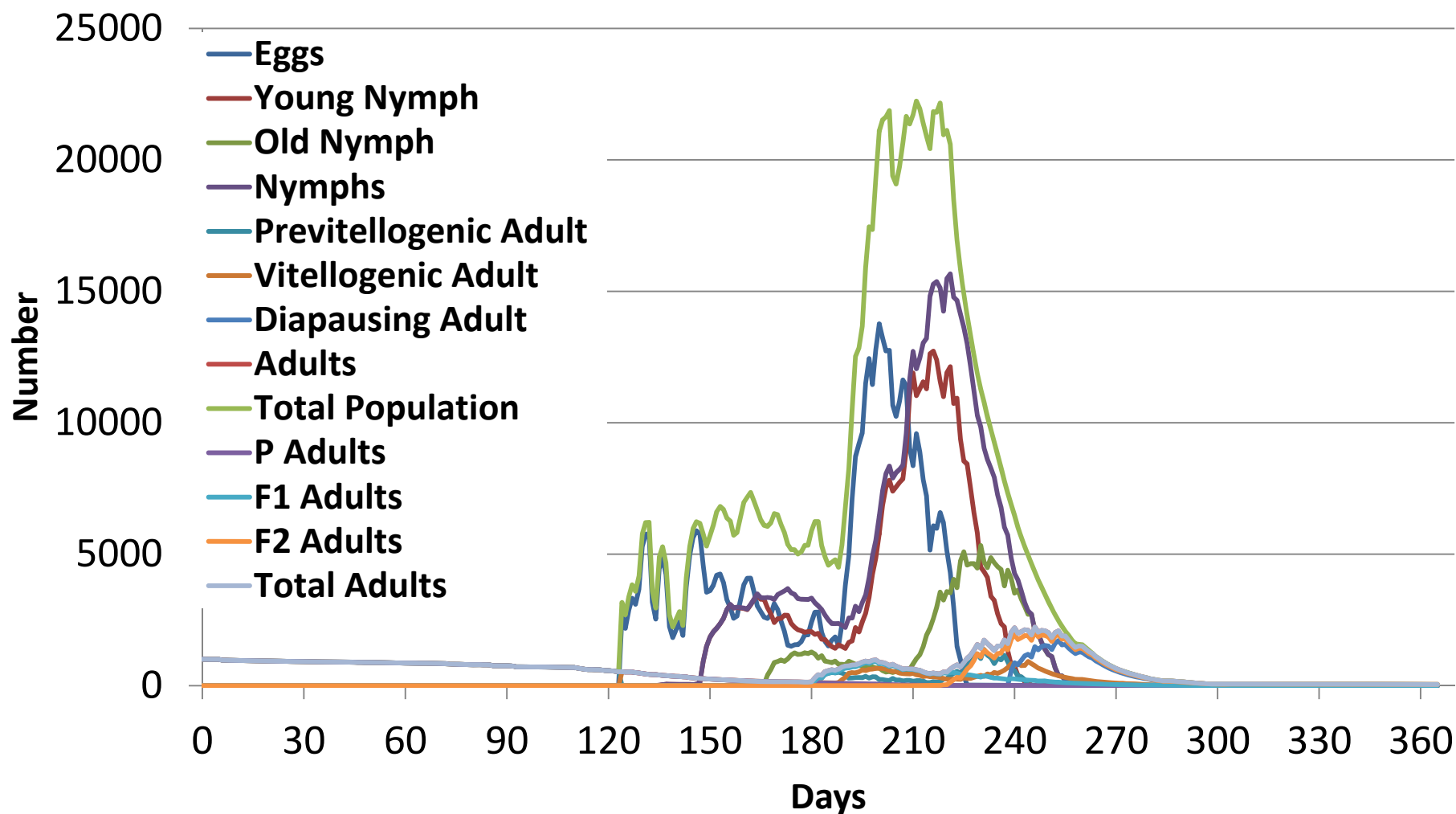
All Nymphs die at 0° C

- Temperature Effects:
 - ✓ Diapause Termination
 - ✓ Development Rate (Stage-Specific)
 - ✓ Mortality Rate
 - ✓ Fecundity

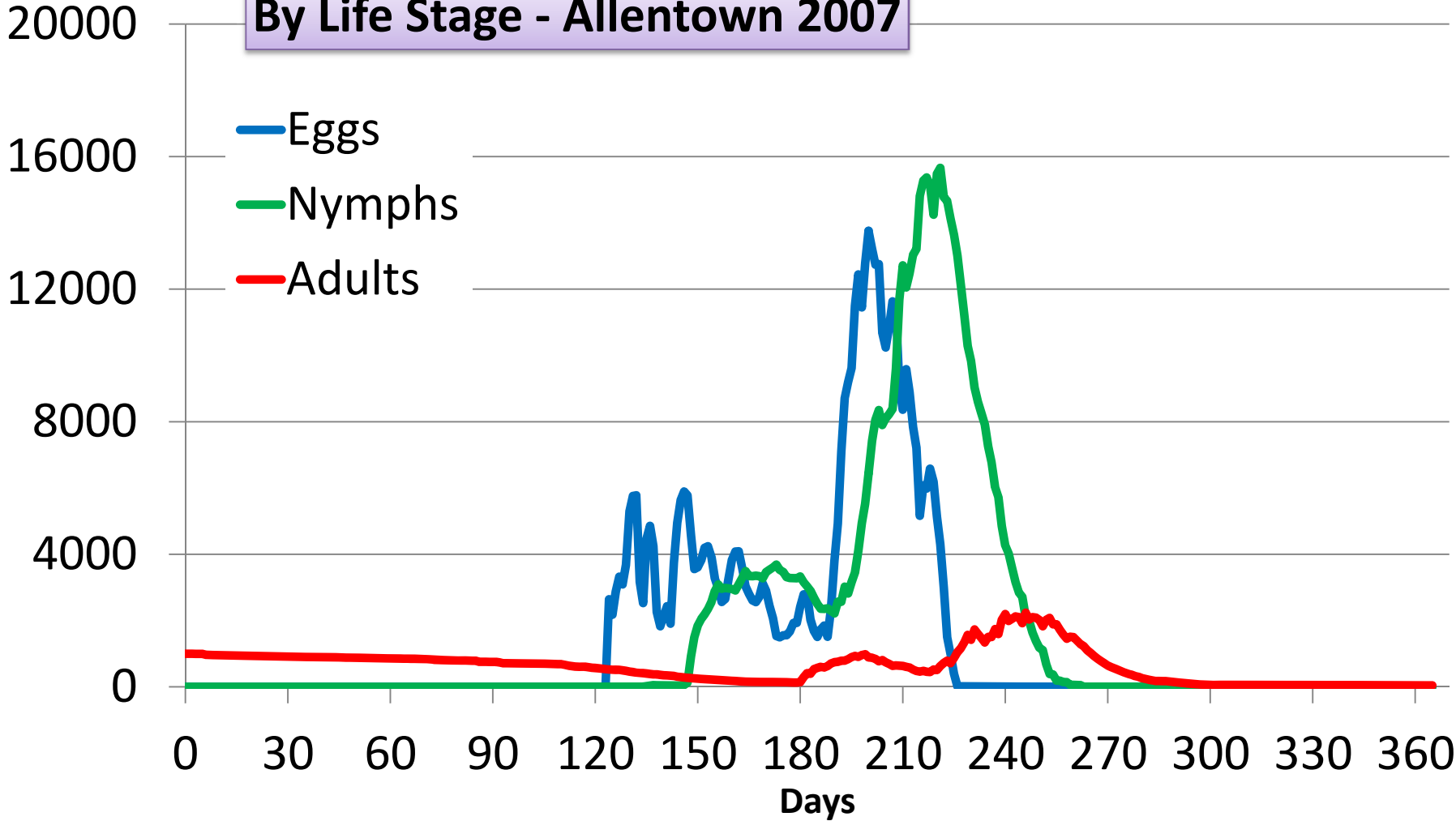
- Photoperiod Effects:
 - ✓ Diapause Induction
 - ✓ Diapause Termination

Abundance and Temporal Distribution of Each Physiological Life Stage

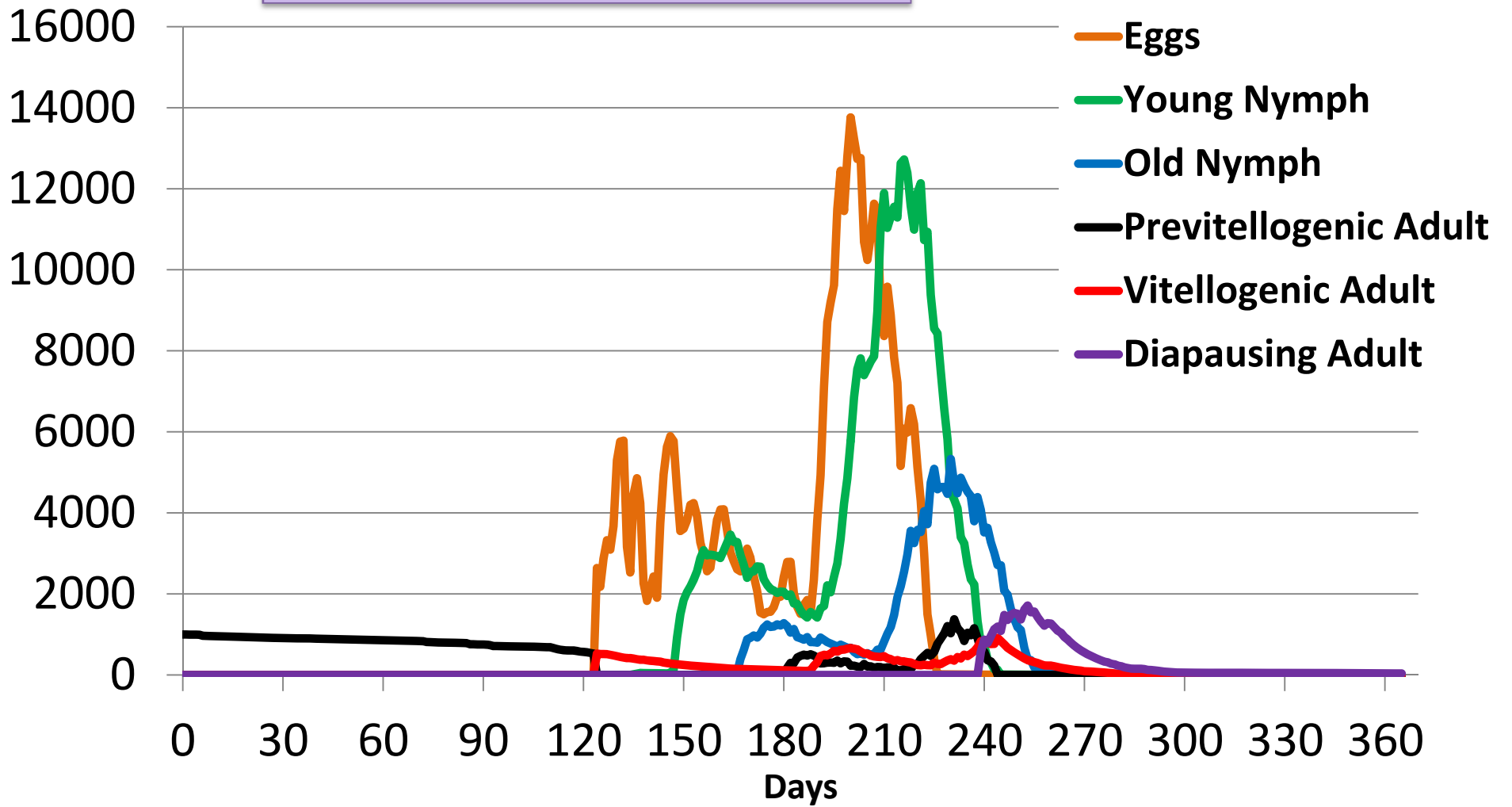
All Life Stages and Generations - Allentown 2007



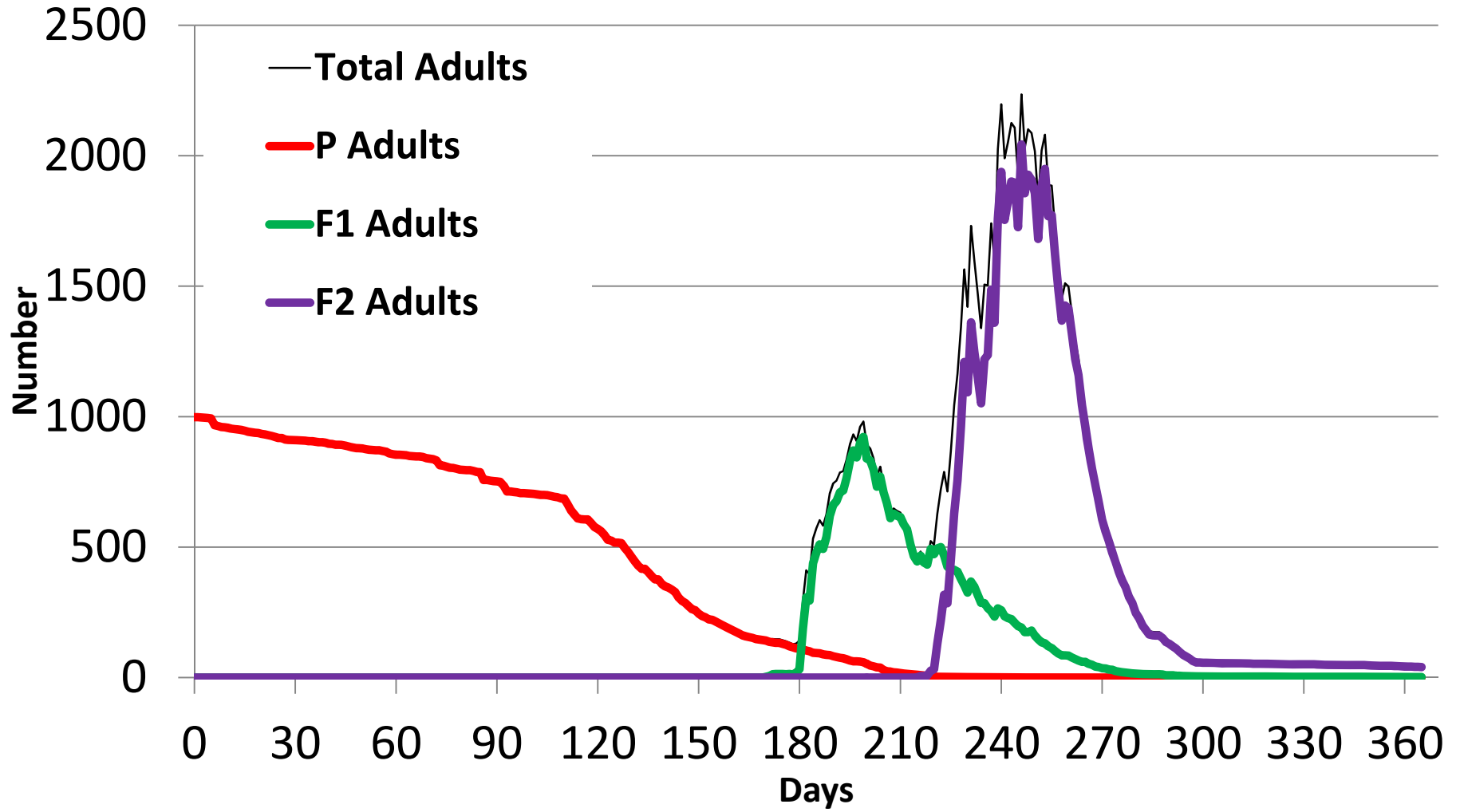
By Life Stage - Allentown 2007



By Life Stage - Allentown 2007



Number of Adults - Allentown 2007



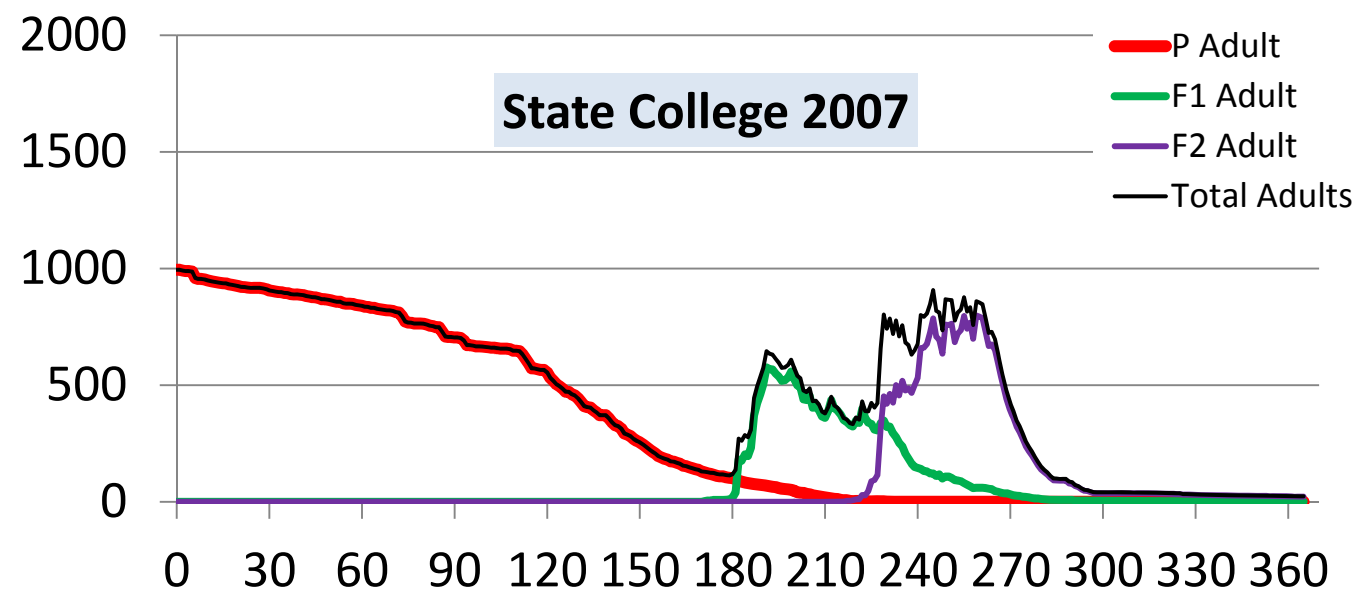
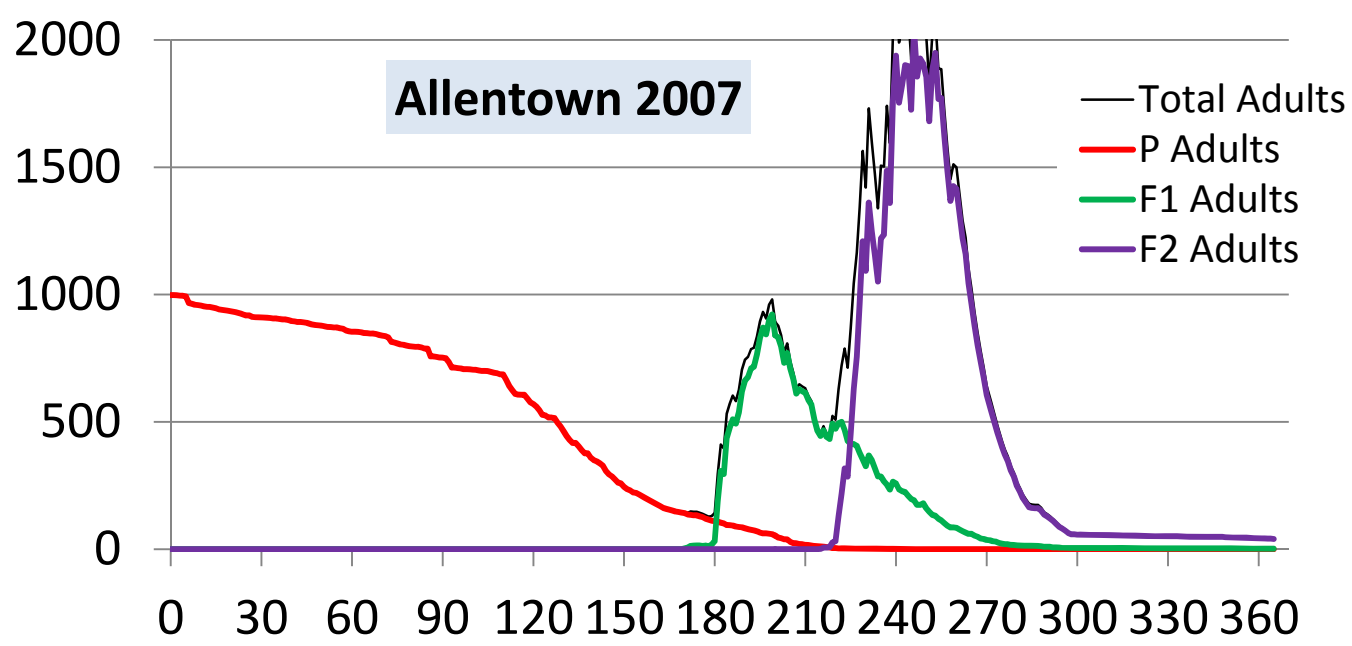
Let's compare:

- ✓ One year (2007)
- ✓ One state (PA)
- ✓ One life stage (adult)

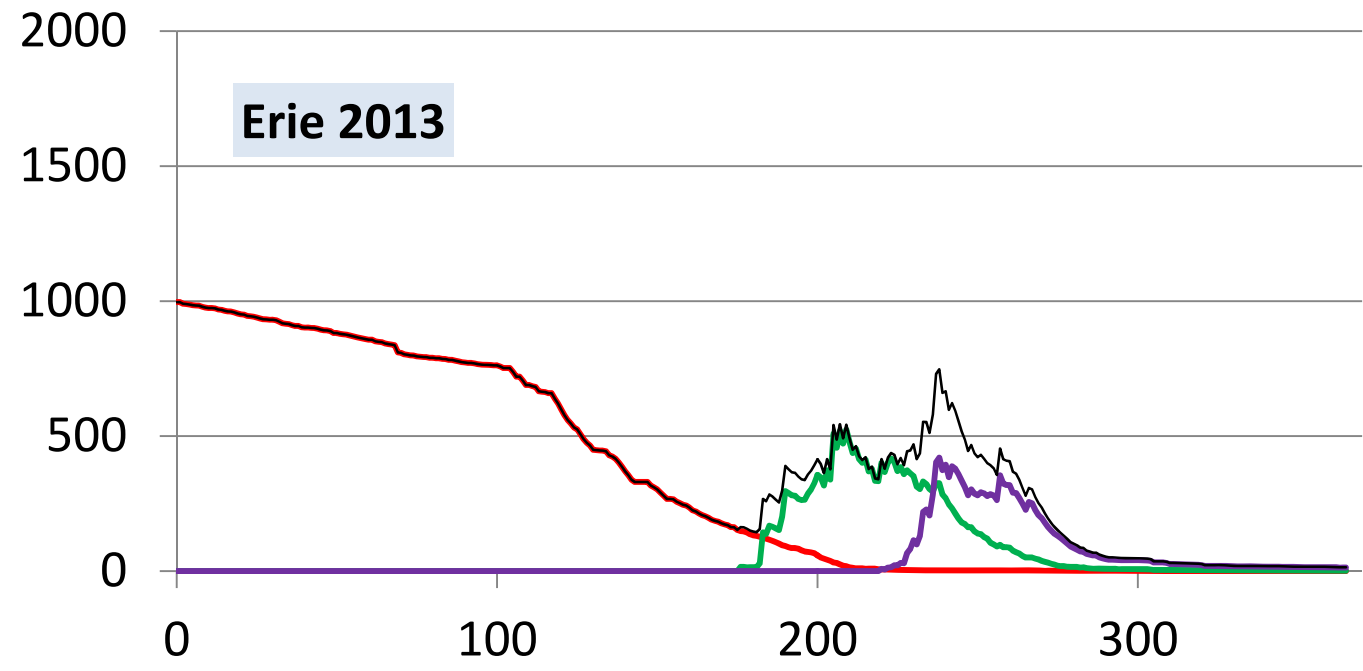
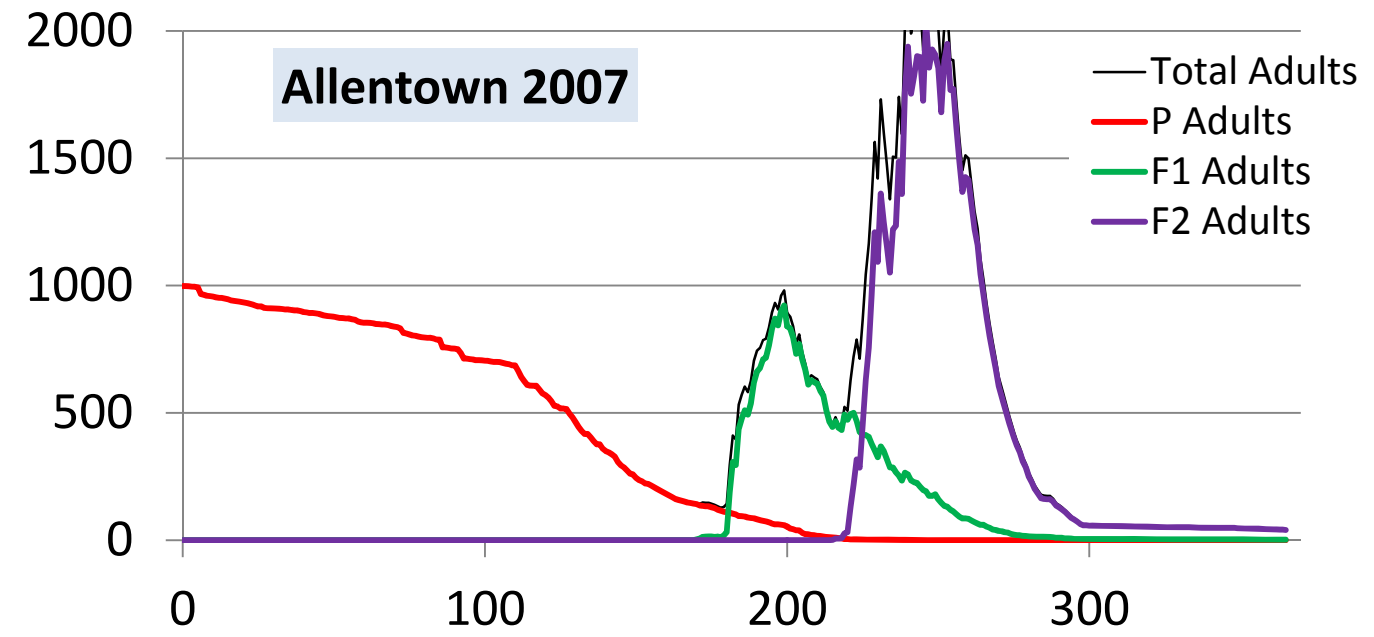
At three locations:

- ✓ Allentown
- ✓ State College
- ✓ Erie

Number of Adults

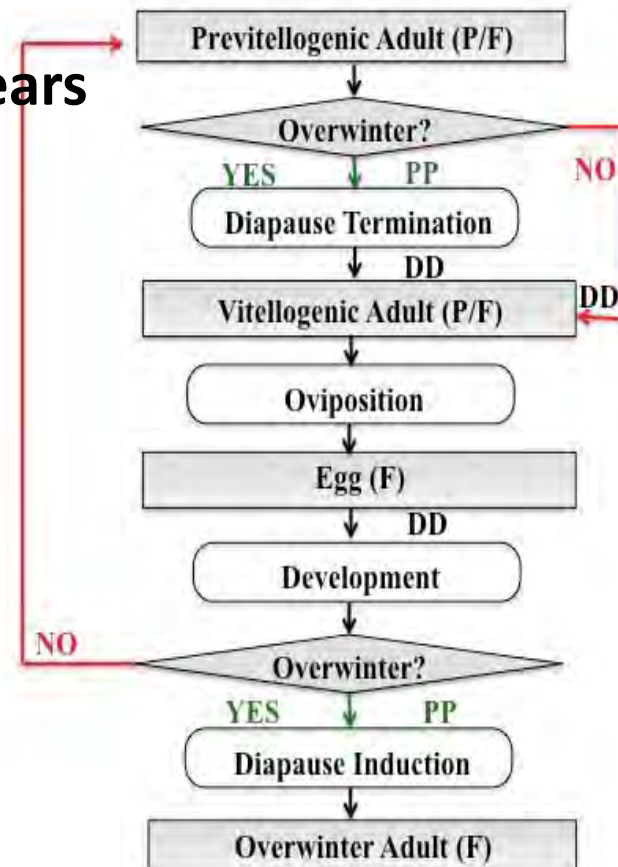


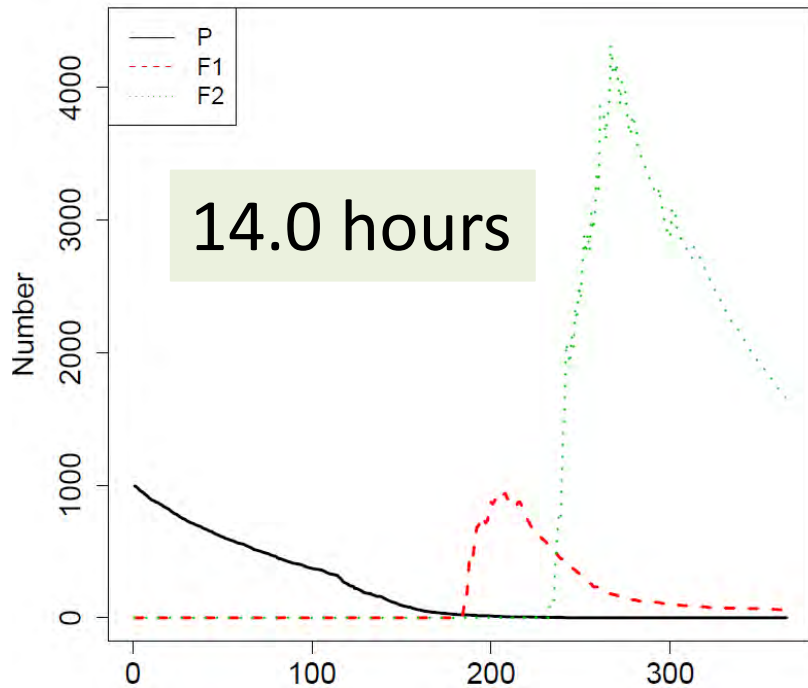
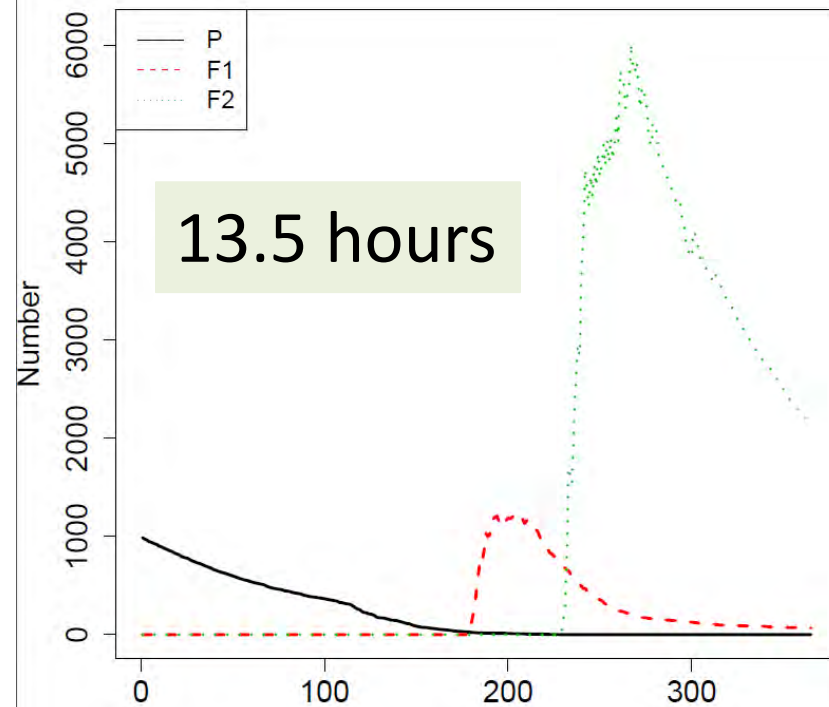
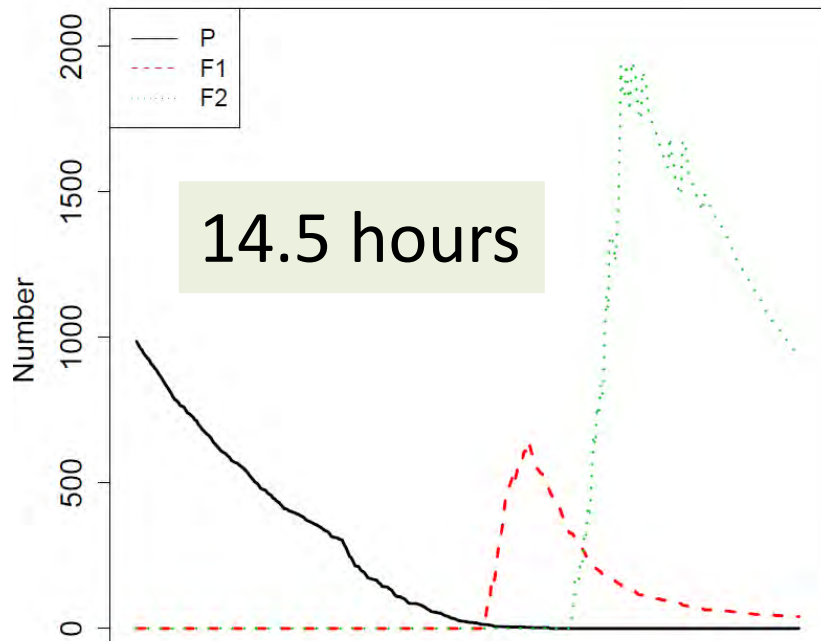
Number of Adults



Next Steps:

- ✓ Complete Modeling Process
 - ✓ Sex Ratio
 - ✓ Validation, Correction
 - ✓ Sensitivity Analysis
 - ✓ Output at Key Locations and Years
 - ✓ Publication





Preliminary Study to Examine Sensitivity of Daylength To Trigger Diapause

Final Step : We Hope to Build a Web Interface though Collaboration with Dr. Nic Wiman, Oregon State University

Model Inputs

Days to Simulate: 50

Temperature C: 15

Deviation of Temperature: 5

Initial Number of Eggs: 0

Initial Number of Larvae: 0

Initial Number of Young Adults: 0

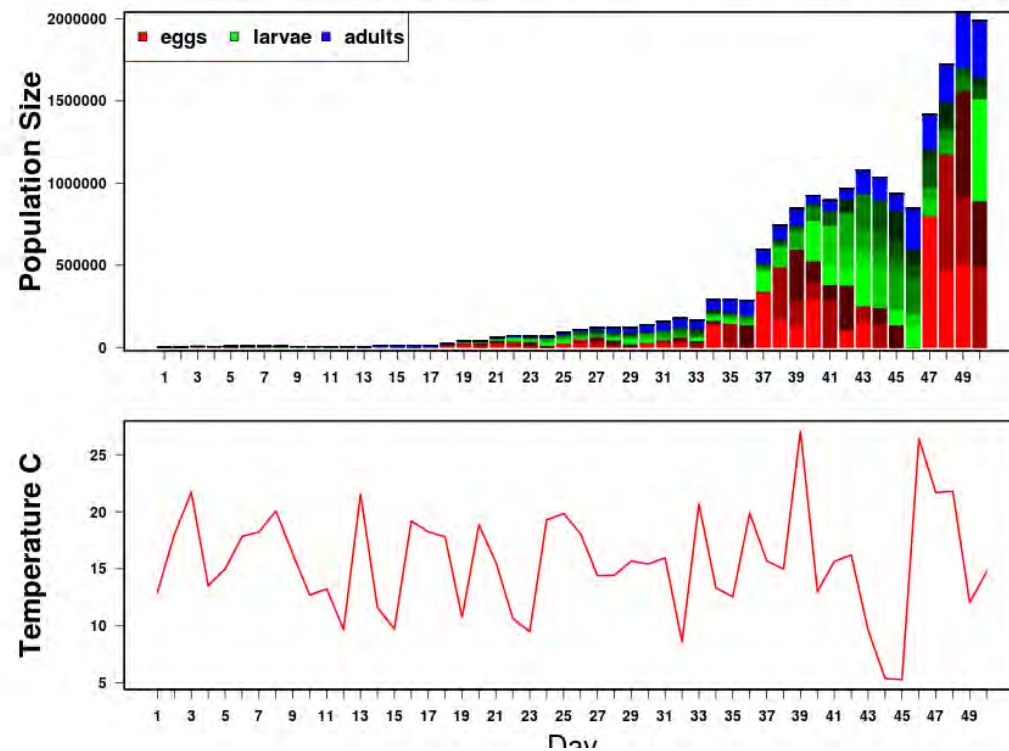
Initial Number of Middle-Aged Adults: 0

Initial Number of Old Adults: 1,000

Final Population

	eggs	larvae	adults	total
1	0.00	0.00	0.00	0.00

Model Output and Environment



1.1.1 : Voltinism ... to Phenology



How many generations advanced to:

- ✓ Abundance and Distribution of Each Physiological Life Stage
- ✓ Effects of both Photoperiod and Temperature
- ✓ Visualization of dramatically overlapping life stages

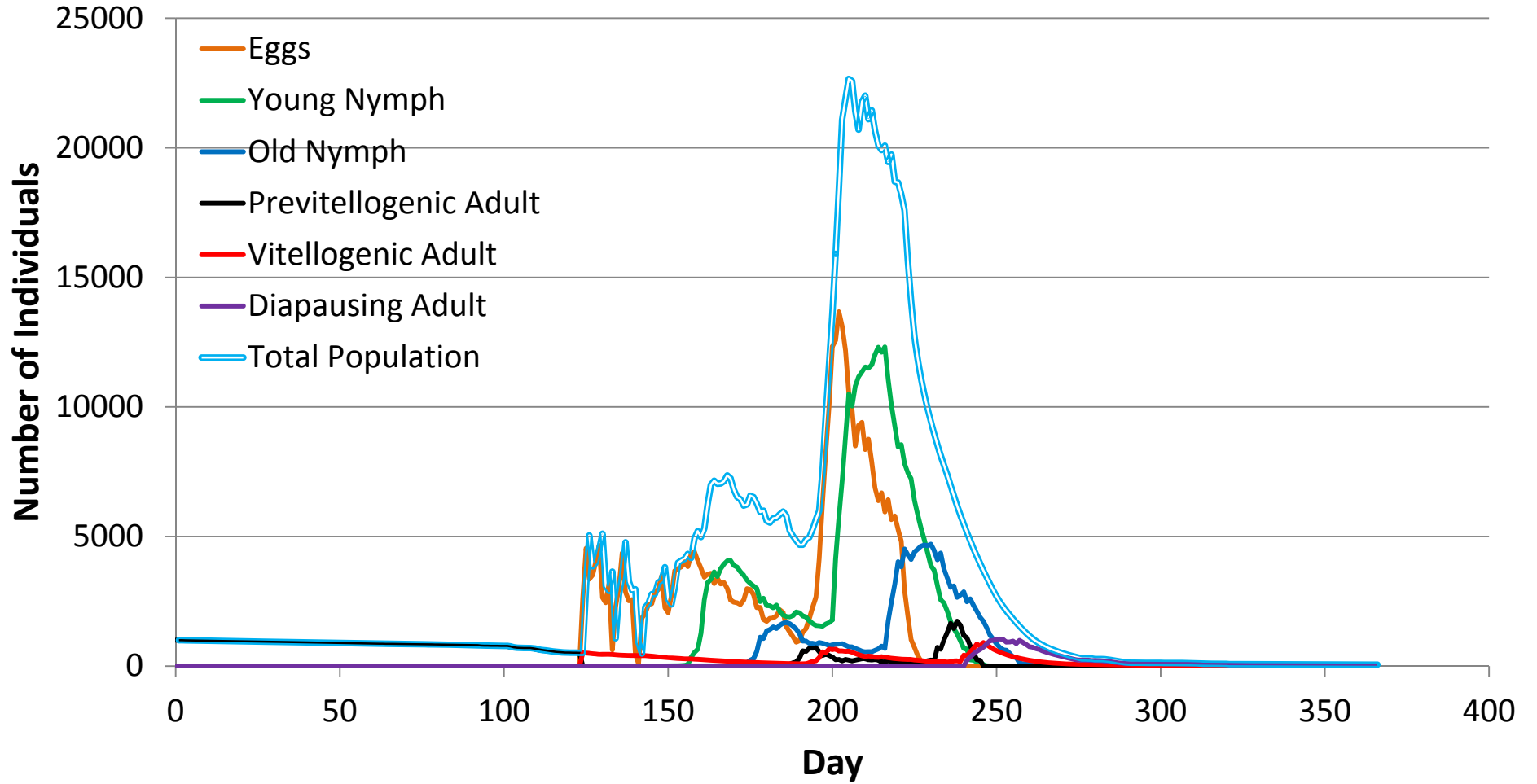
Will This Help Management?

- ✓ Monitoring Varies Among Life Stages
- ✓ Monitoring May Vary Among Types of Adults
- ✓ Biocontrol is stage specific
- ✓ Diapause control (sanitation) might become relevant

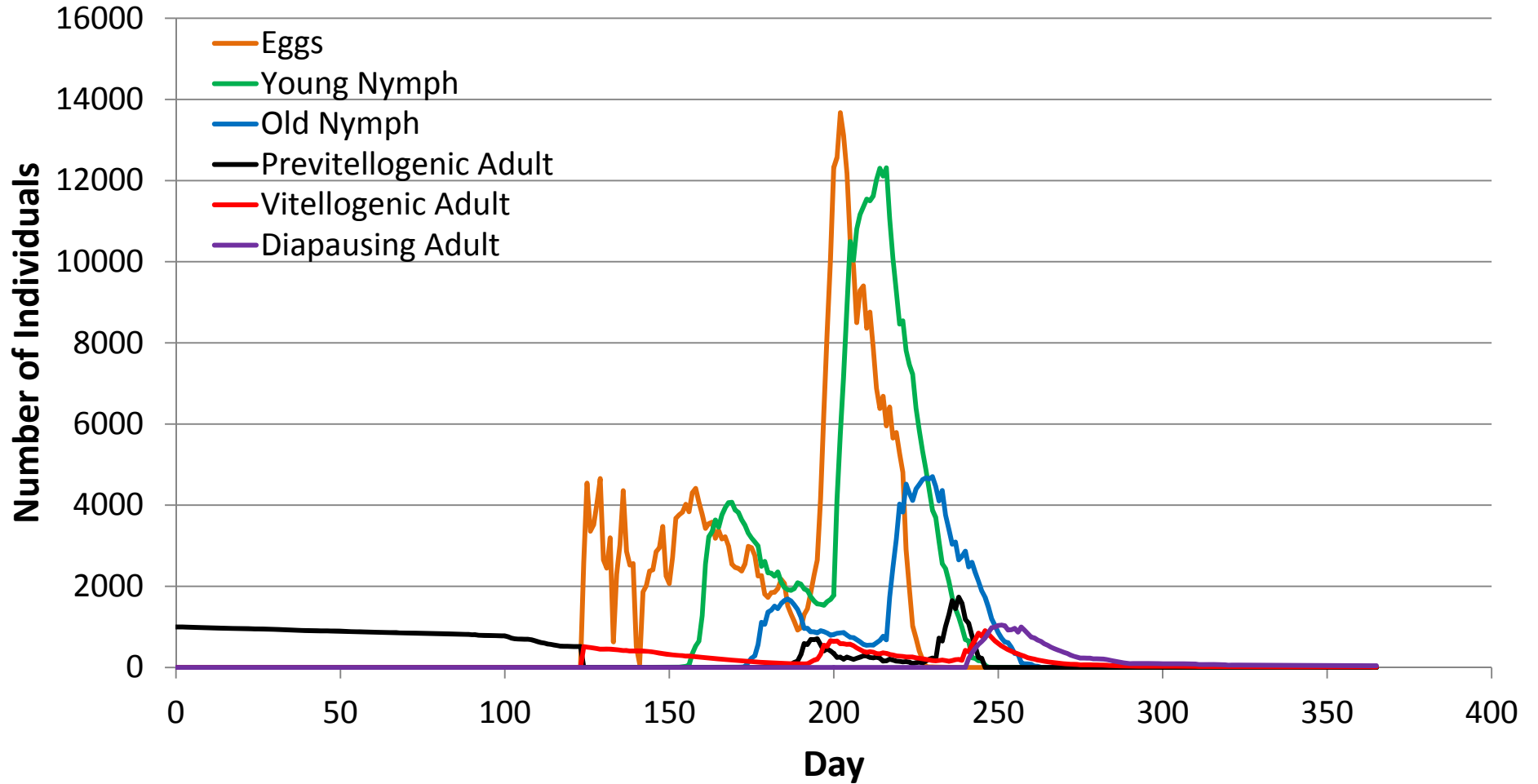
Extension : Web Interface

Science : Phenology Models for Insects that Overwinter as Adults

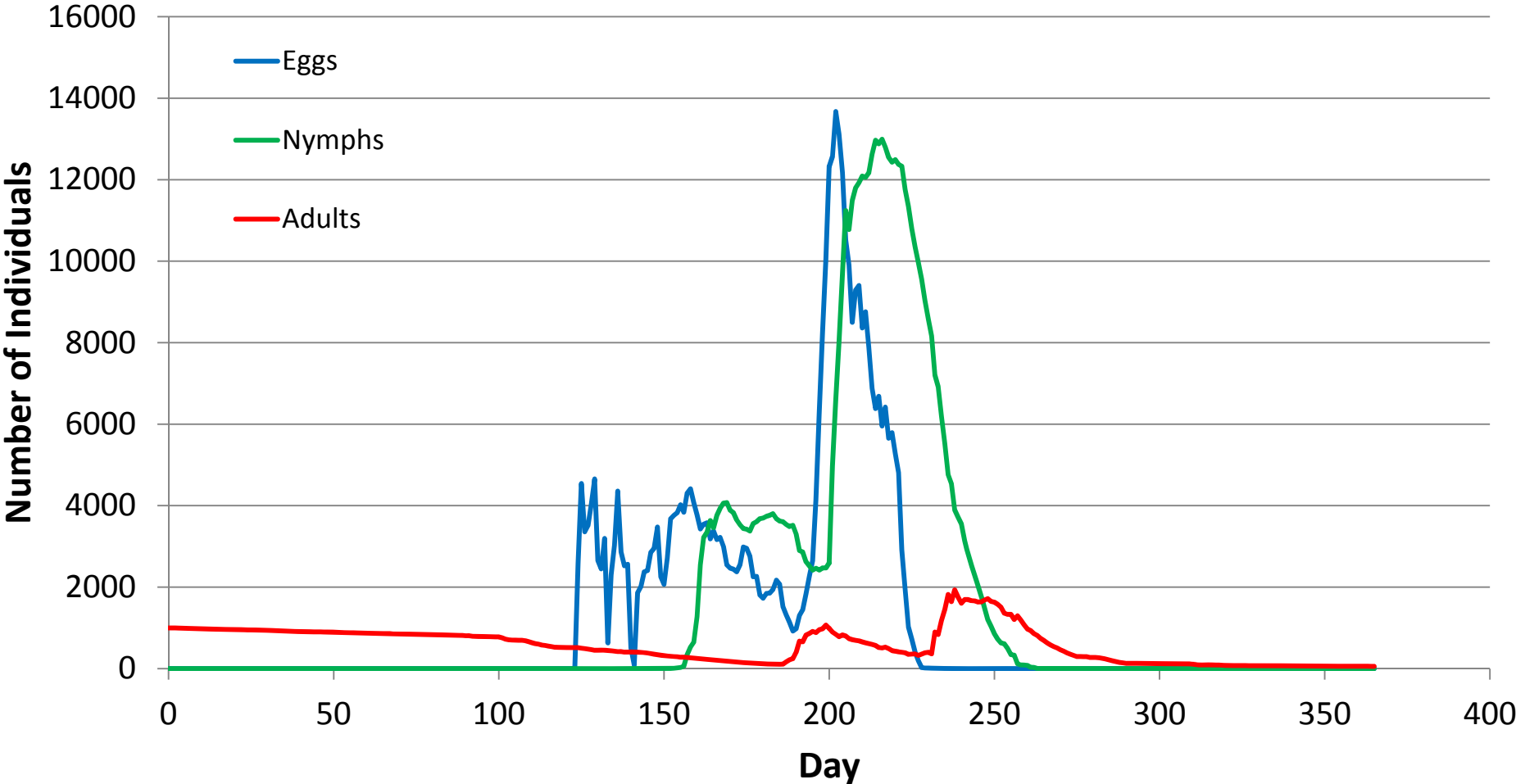
By Life Stage and Total - Allentown 2008



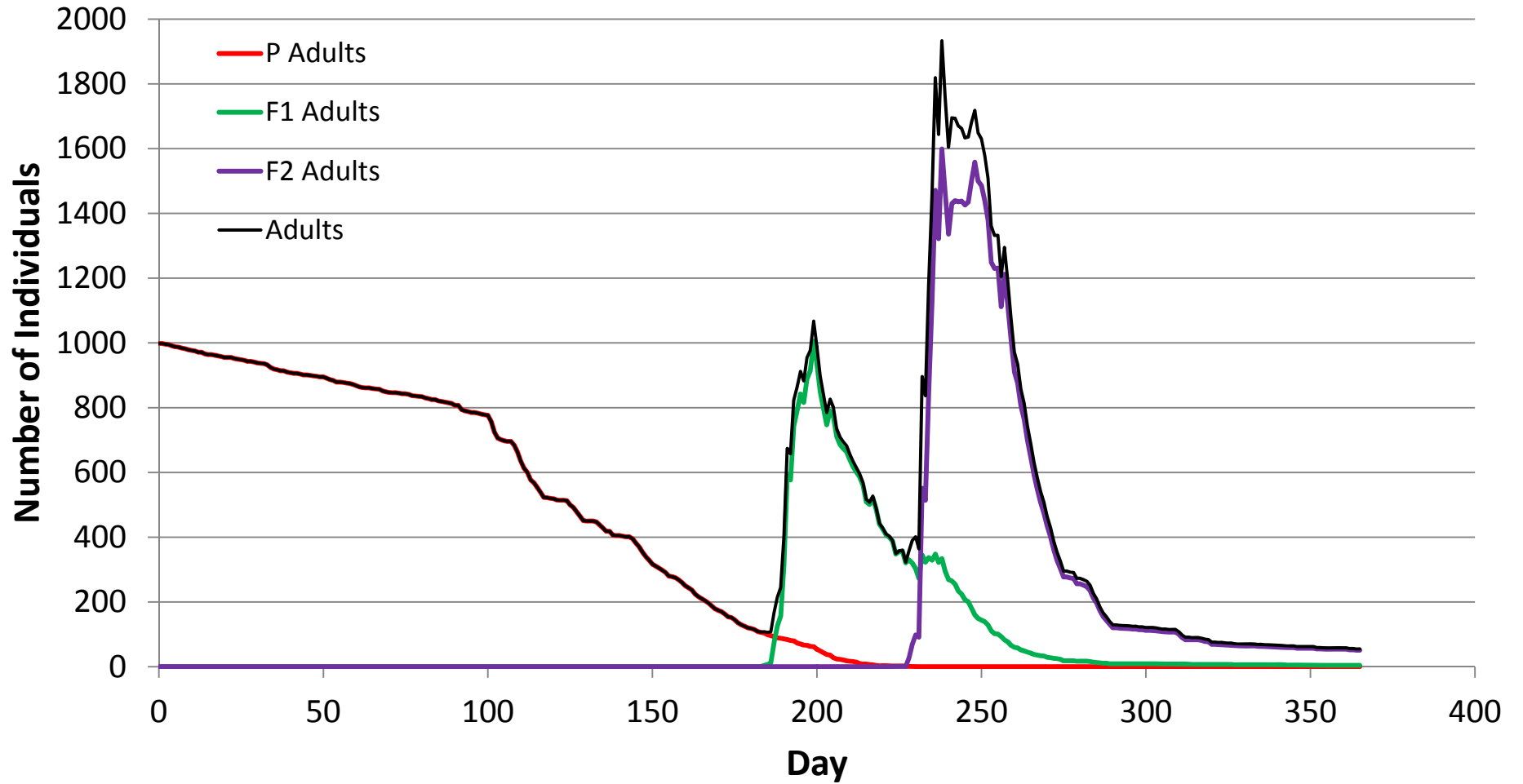
By Life Stage - Allentown 2008



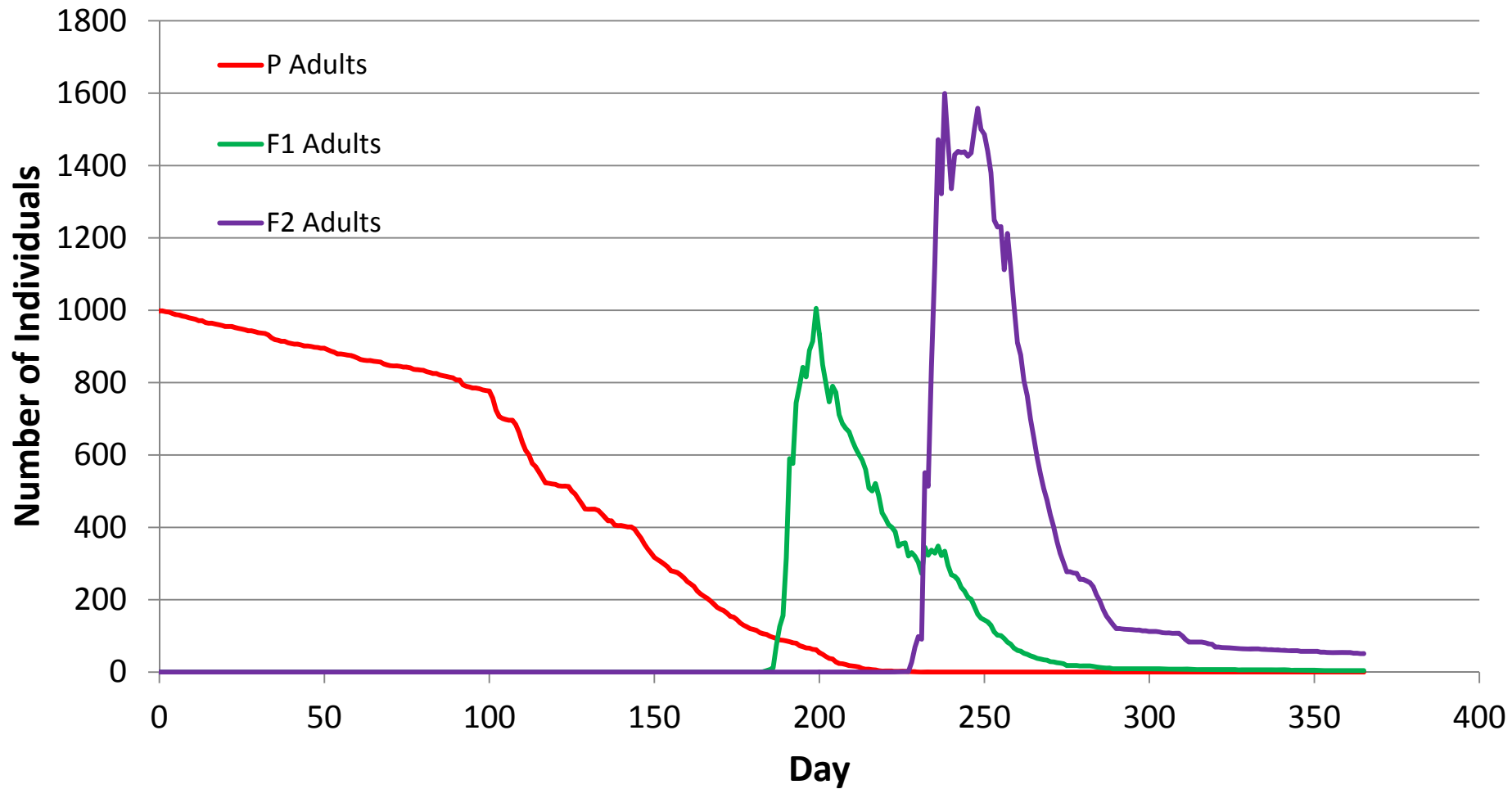
By Life Stages - Allentown 2008



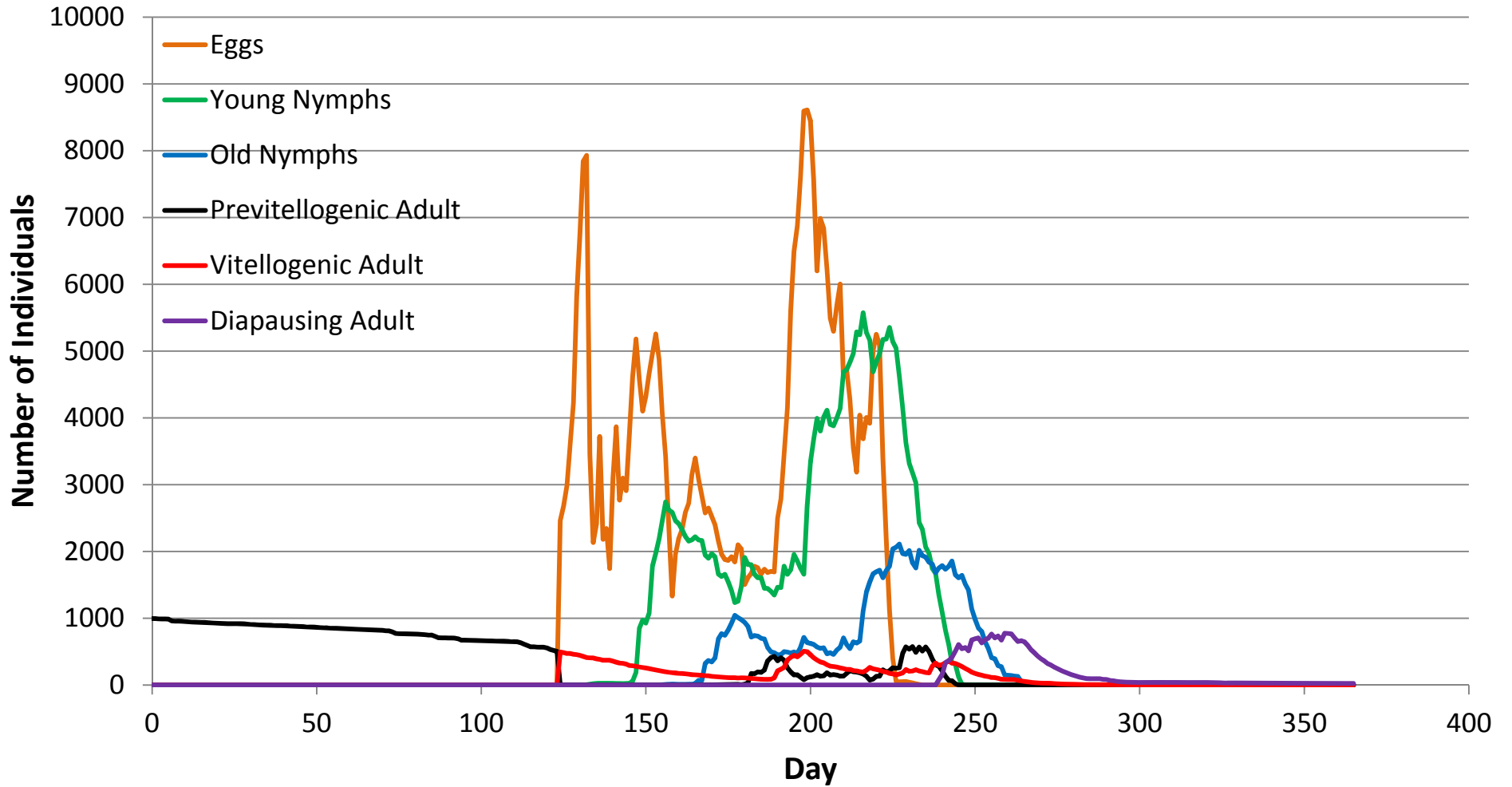
Number of Adults - Allentown 2008



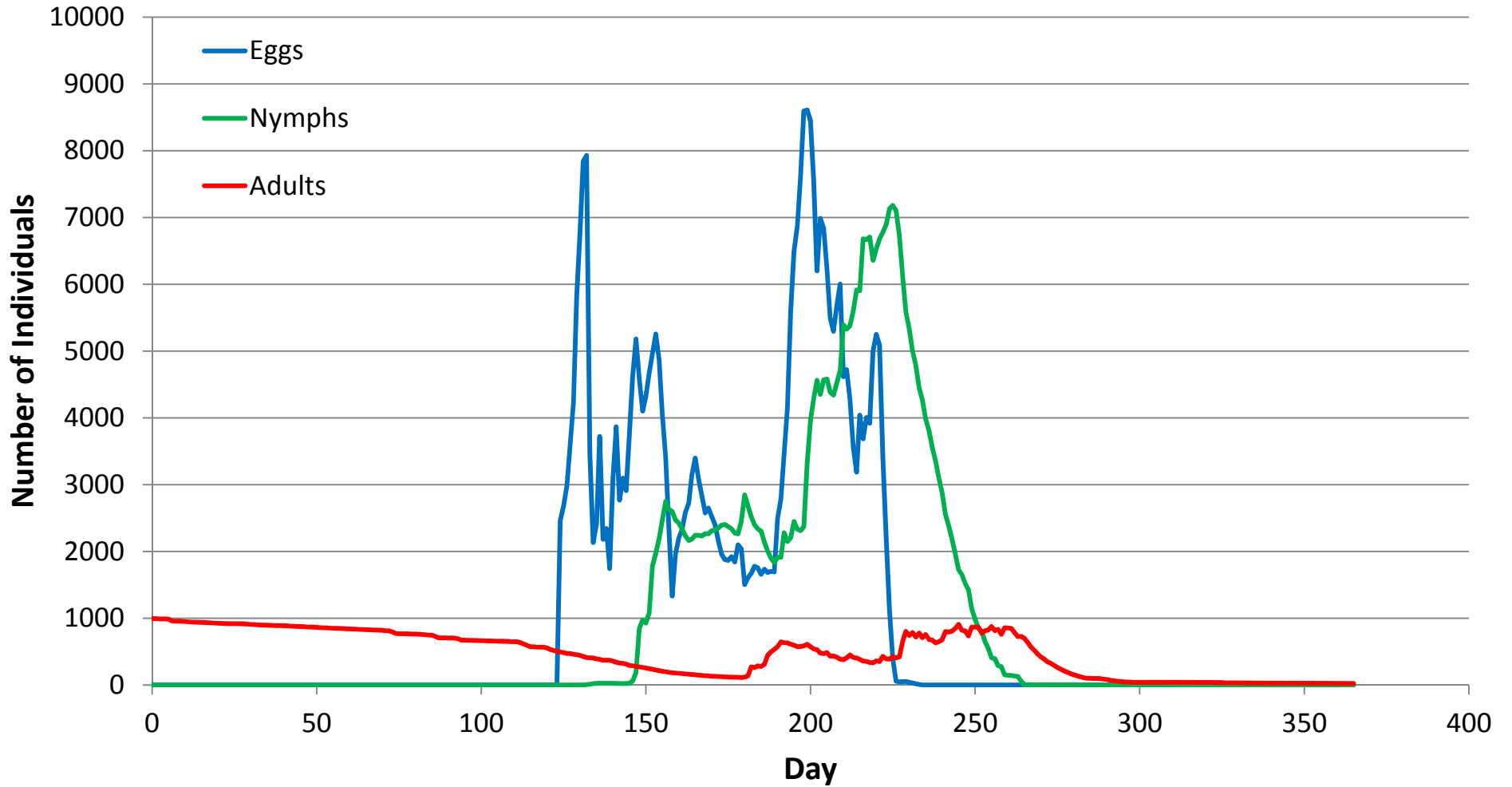
Number of Adults - Allentown 2008



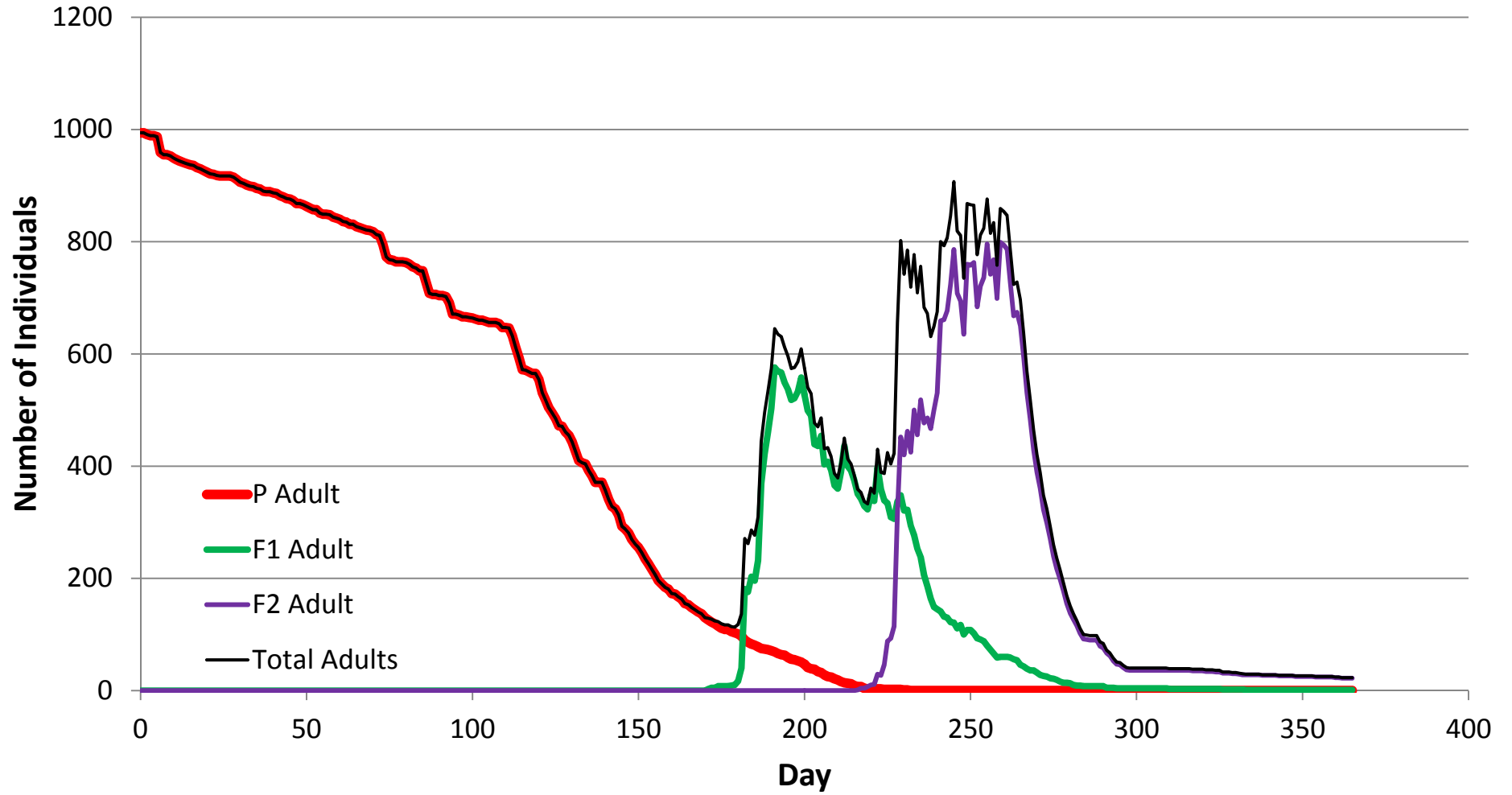
By Life Stage - State College 2007



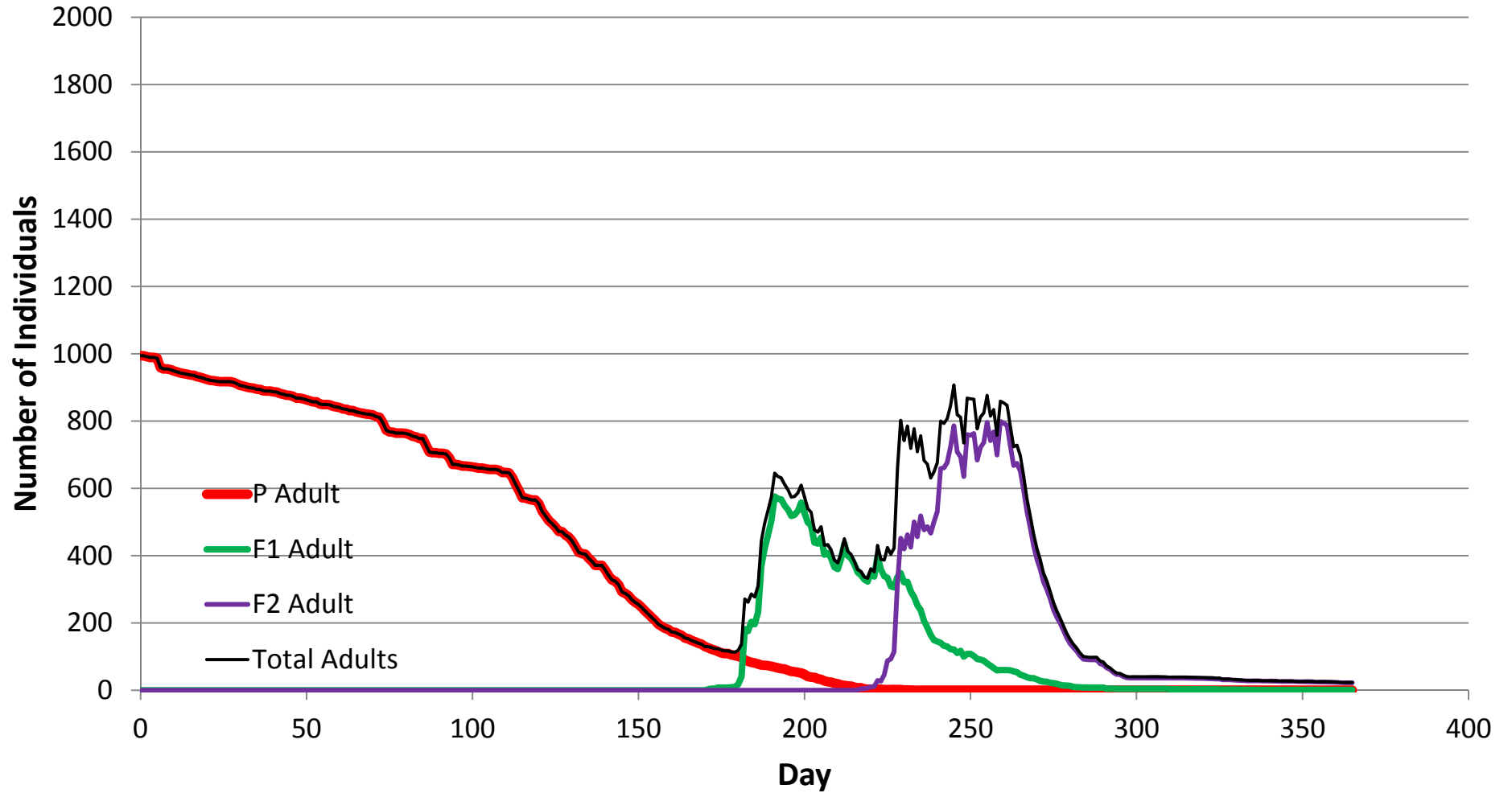
By Life Stages - State College 2007



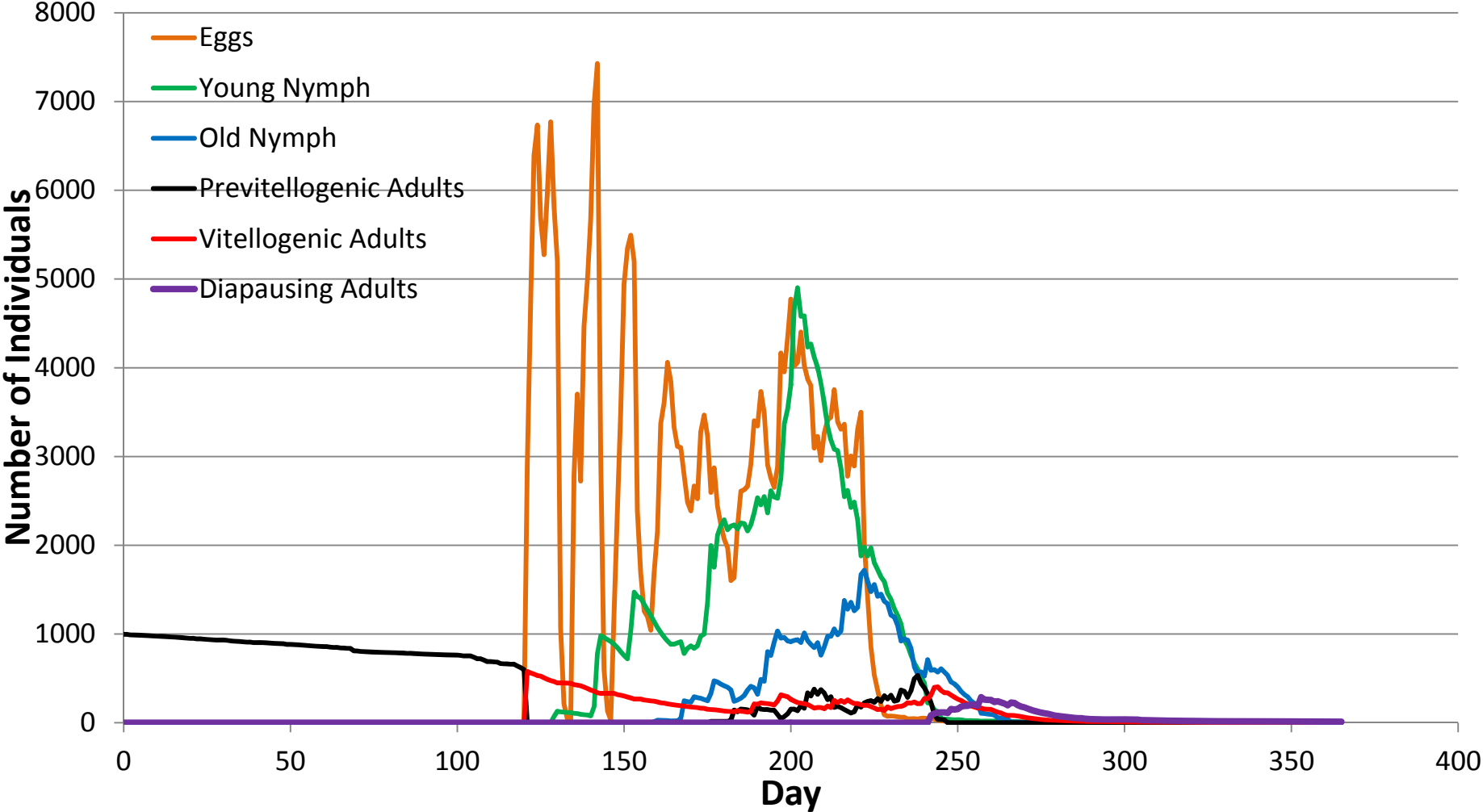
Number of Adults - State College 2007



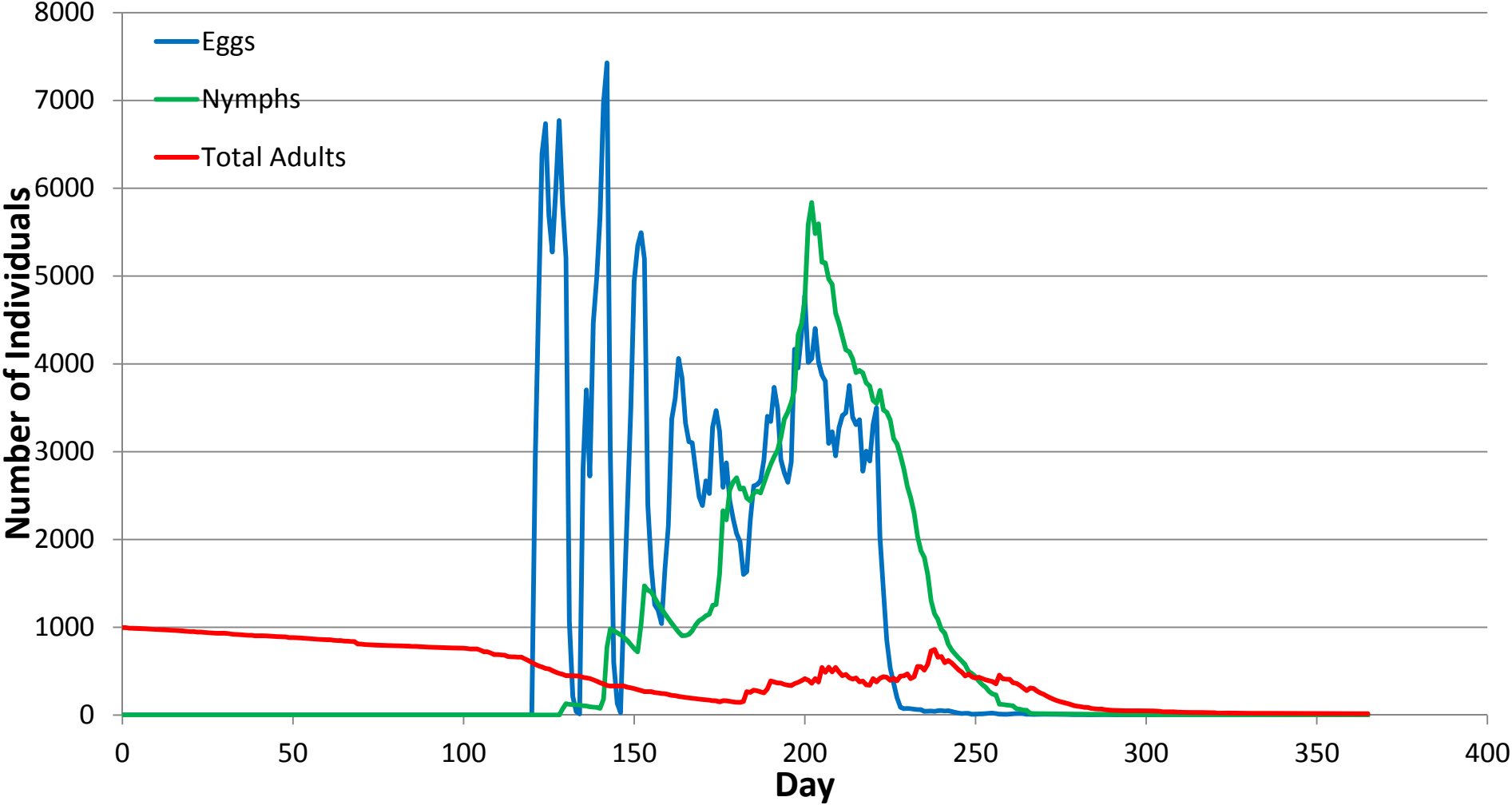
Number of Adults - State College 2007



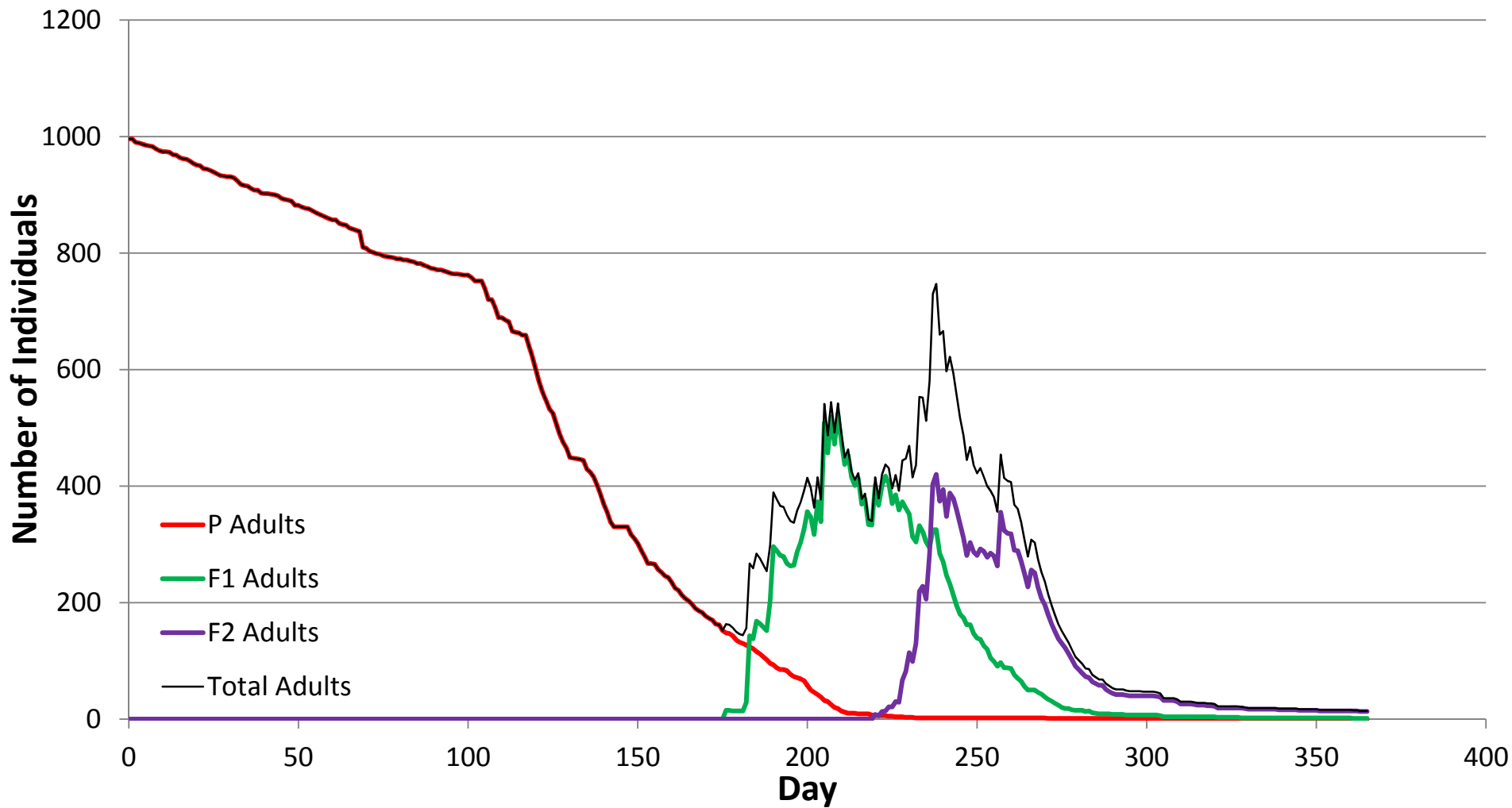
By Life Stages - Erie 2013



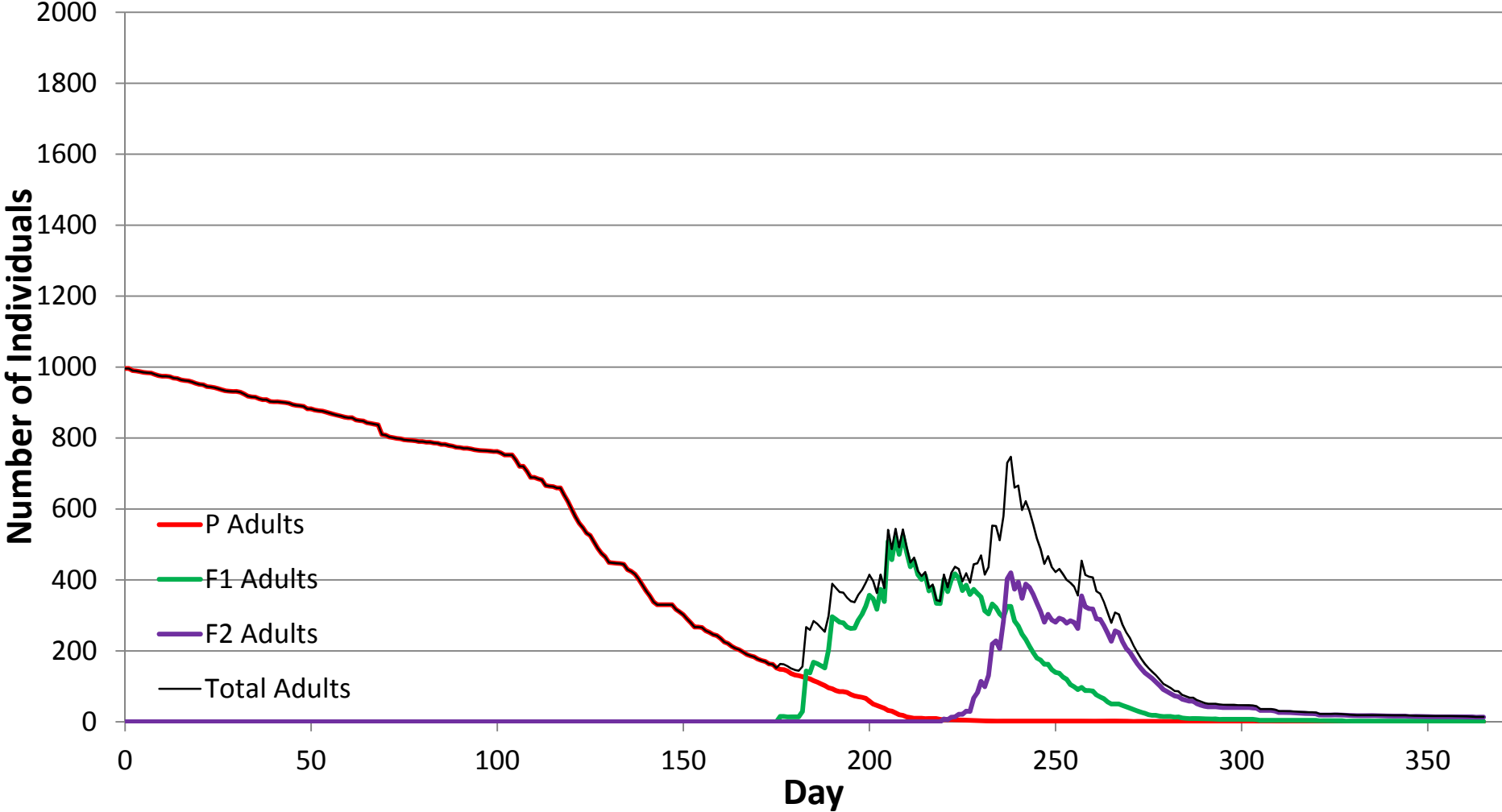
By Life Stages - Erie 2013



Number of Adults - Erie 2013



Number of Adults - Erie 2013



By Life Stage , and Total Population - Allentown 2007

